

Section of Epidemiology and Preventive Medicine

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The Epidemic of Poliomyelitis in Copenhagen, 1952

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DENMARK, like Sweden, has known poliomyelitis for quite a long time. We have had epidemics for as long as epidemic polio has been on record. The general trend in our country, as in other countries where epidemic polio has been established for decades, has been bigger epidemics, higher incidence of paralysis in the older age groups and a steadily increasing percentage of gravely-ill cases.

The metropolitan area of Copenhagen has a population of about 1,200,000 people served by a single hospital for communicable diseases, the Blegdam Hospital of 500 beds. During the last five months of 1952 we received about 3,000 patients with the diagnosis of poliomyelitis, roughly one-third with paralysis, two-thirds without. This, of course, was quite unusual but still more unusual was the high incidence of respiratory insufficiency with or without impairment of swallowing. Almost one-third of the paralysed patients belonged to this group.

At times we had 70 patients requiring artificial respiration; around New Year we still had 50 to 60 requiring it. To-day there are between 25 and 30 left over from the 1952 epidemic still dependent on artificial respiration.

The epidemic culminated about September 1. During the week August 28 to September 3 our hospital admitted 335 patients with polio or nearly 50 cases daily. And remember, about one-tenth of these patients were suffocating or drowning in their own secretions.

At our disposal we had one tank respirator (Emerson) and six cuirass respirators. This equipment naturally proved wholly insufficient when the epidemic got into its stride.

We had to improvise; we had to find ways of avoiding the impossible situation of having to choose which patient to treat in the available respirators and which patient not to treat. Every single patient should have his chance and an equal chance of survival.

In former years our therapeutic results in cases with respiratory insufficiency and involvement of the lower cranial nerves and the bulbar centres have always been very bad. During the eleven years 1934 to 1944 respirator treatment was used in 76 cases with a mean fatality rate of 80%. Only cuirass respirators were used. Fatality was 94% in respiratory paralysis with bulbar involvement and 28% in respiratory paralysis without bulbar involvement.

In 1948 we started to use tracheotomy in all cases where it proved impossible to maintain an open airway because of pooling of secretions and aspirations into the lungs. In the U.S.A. this procedure seems to have had a beneficial influence on prognosis. In our hands this has not been so. Thus the prognosis of poliomyelitis with respiratory insufficiency was rather gloomy at the outbreak of the 1952 epidemic in Copenhagen.

In the beginning of August when it became evident that an epidemic was imminent, one of my assistants, Dr. Lindahl with the aid of six senior medical students, was given the job of visiting the homes of all the polio patients. We drew up an extensive questionnaire including a host of questions. After eliminating all the doubtful cases about 2,300 cases of poliomyelitis remained—paralytic or non-paralytic.

Every seventh case of polio (316 in all) in chronological order was compared with an equal number of controls from the population. The polio and the control material were identical in age, sex and district. They were compared in a great many respects, in most of which no difference was found. Yet, in other respects, there *seemed* to be a difference, though this was not statistically significant. These concerned the incidence of head trauma inside one month before onset, the frequency of vaccination, intramuscular injections, the taking of blood samples, surgical intervention in the oropharynx, and pregnancy.

In a few points the difference was so conspicuous as to be highly significant statistically. This has to do with contagiousness.

TABLE I
CONTAGIOUSNESS I (Lindahl and co-workers)
Poliomyelitis

Contact with polio	Children			Adults			Total			Children			Adults			Total		
	No.	%		No.	%		No.	%		No.	%		No.	%		No.	%	
Yes ..	64	28.4		25	27.5		89	28.2		12	5.4		1	1.1		13	4.1	
No ..	161	71.6		66	72.5		227	71.8		211	94.6		92	98.9		303	95.9	
	225	100		91	100		316	100		223	100		93	100		316	100	

TABLE II
CONTAGIOUSNESS II (Lindahl and co-workers)
Poliomyelitis

Contact with minor illness	Children			Adults			Total			Children			Adults			Total		
	No.	%		No.	%		No.	%		No.	%		No.	%		No.	%	
Yes ..	77	34.2		29	31.9		106	33.5		14	6.3		4	4.3		18	5.7	
No ..	148	65.8		62	68.1		210	66.5		209	93.7		89	95.7		298	94.3	
	225	100		91	100		316	100		223	100		93	100		316	100	

About 60% of the patients had been in contact either with patients diagnosed as polio, or with patients having a minor illness. Only 9% in the control group come into this category. And, naturally, the control group chosen at random did include a few polio patients. These figures are strongly suggestive of the person-to-person contagiousness of poliomyelitis.

The intra-family contagiousness of the disease is also evident from Table III, which shows later cases of poliomyelitis or minor illness in the family *after* hospitalization of patient in poliomyelitis group.

TABLE III
CONTAGIOUSNESS III (Lindahl and co-workers)

	Poliomyelitis			Controls		
	Children %	Adults %	Total %	Children %	Adults %	Total %
Later cases of polio ..	8.4	5.5	7.6	1.3	0	0.9
Cases of minor illness ..	18.7	13.2	17.1	4.0	1.1	3.2
Polio or minor illness ..	26.2	18.7	24.1	5.4	1.1	4.1
Number	225	91	316	223	93	316

TREATMENT OF THE CRITICALLY ILL

I do not want to dramatize the state of affairs existing in the middle of August 1952, but it certainly was desperate! Nearly all our patients with bulbar poliomyelitis had died!

On August 25 we decided to call into consultation our anaesthetist colleague, Dr. Bjørn Ibsen, as we thought positive pressure breathing—as used in modern anaesthesia—might be of value; and on August 27 the first patient received the treatment, which soon became our method of choice in patients with impairment of swallowing and reduced ventilation—a tracheotomy was performed just below the larynx and a rubber cuff-tube was inserted into the trachea with manual positive pressure ventilation from a rubber bag (bag-ventilation).

We were now in a position to treat every single patient requiring respiratory aid. In this manner we avoided being placed in the dreadful situation of having to choose. Patients kept pouring in, 30-40-50 a day, including 6-12 patients per day with respiratory insufficiency and/or impairment of swallowing—all of whom had to have special treatment. At the height of the epidemic the staff of doctors permanently on the job was 35-40; we had about 600 trained nurses and 250 medical students coming in daily, working in relays.

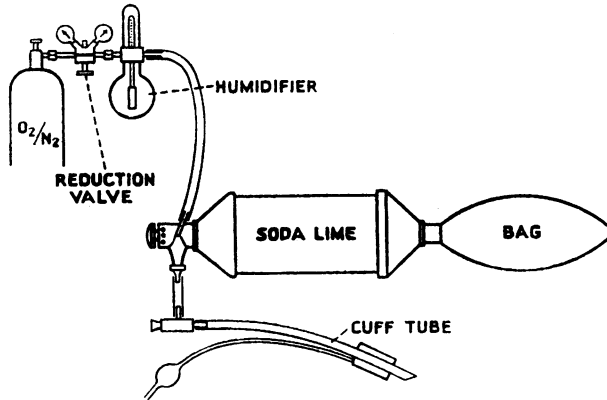


FIG. 1.

Fig. 1 shows schematically the various parts of the simple equipment used by us in about 200 patients subjected to manual bag ventilation. The upper part of the cuff-tube has a side branch connected with a metal container packed with granulated soda lime (Waters' canister) from which a rubber tube goes to a cylinder containing equal parts of compressed oxygen and nitrogen. A rubber bag is attached to one end of the canister, and a valve at the other end permits regulation of the pressure in the system. The cuff-tube is closed with a rubber stopper. If aspiration is needed, the stopper is removed and a Tiemann's catheter is introduced mounted on a jet suctioning apparatus. We have mostly used the ejector effect of a cylinder containing compressed air, which is very effective and is independent of electric power.

A good humidifier is essential, otherwise incrustation of secretions may occur.

In the acute phase several competing factors are involved, often difficult to diagnose and difficult to keep apart. These are: virus disease of the central nervous system; hypoxia; retention of carbon dioxide; and vasomotor shock.

In most cases one or more of these syndromes are present, the patients presenting a mixed clinical picture. Only careful clinical observation, supplemented by various biochemical tests, can guide us through this jungle of diagnostic difficulties and lead to a rational therapy. The clinical picture of these states is well known, I shall therefore only just mention that hypertension in patients with acute polio—especially bulbar polio—is not always due to hypercapnia. Some patients undoubtedly have hypertension due to central lesions, but this, of course, can only be ascertained after ruling out other etiologies.

Our patients with respiratory insufficiency and/or impairment of deglutition have been treated in one or other of the four following ways, often in combination: (1) tracheotomy and positive pressure ventilation; (2) tracheotomy alone; (3) respirator—tank or cuirass; (4) postural drainage and permanent stomach tube.

The indications have been:

(1) For *tracheotomy and positive pressure ventilation*: accumulation of secretions in the upper airways, insufficiency of swallowing, ineffective cough, and a rapidly decreasing vital capacity.

(2) For *tracheotomy alone* eventually in combination with permanent stomach tube with continuous suctioning and postural drainage: pooling of secretions in the hypopharynx, paralysis of swallowing, ventilation normal or slightly to moderately decreased.

(3) For *respirator alone*: respiratory insufficiency without accumulation of secretions.

(4) For *postural drainage* often in combination with an indwelling stomach tube: impairment of swallowing without stagnation of secretion or slight accumulation of secretions and normal or slightly deficient respiration.

Following in the main these indications the great majority of our patients requiring special treatment had tracheotomy and bag ventilation. Very few patients could be tided over in respirators alone, either of the cuirass or the tank type.

I am quite aware that we may be under suspicion of having used tracheotomy and bag ventilation too freely. Yet, in 40% where tracheotomy and bag ventilation was the final therapeutic measure, treatment had begun with postural drainage or in a respirator. In all these cases we had to resort to tracheotomy and bag ventilation as a more radical therapy because of alarming symptoms of suffocation.

We soon came to the conclusion that in most acute cases it is impossible to differentiate between so-called central and peripheral respiratory insufficiency. The degree of the insufficiency was mainly estimated on a clinical basis. Practically all these patients had a feeble cough and inadequate or paradoxical respiratory movements.

In the more severe cases they also showed restlessness, disorientation, increasing blood pressure and cyanosis and, very often, accumulation of secretions in the airways and atelectasis.

An important point is the rate of progression of peripheral paralysis. If the upper extremities are involved, the temperature is high and the disease only a few days old, respiratory insufficiency will usually follow. Repeated measurement of the vital capacity has, in many cases, been of great help.

That our therapeutic principles have been fairly sound is, I think, borne out by the fact that our results steadily improved. Complications were very frequent (Table IV).

TABLE IV.—FREQUENCY OF COMPLICATIONS
AND THEIR RELATION TO MORTALITY RATE

345 patients with respiratory insufficiency and/or
impairment of swallowing. Mortality rate 41%

Complications	Frequency		Mortality rate	
	No. of patients	Per cent	No. of patients	Per cent
Shock	134	39	90	67
Paralytic ileus	114	33	49	43
Hyperpyrexia	66	19	60	91
Hypertension	65	19	27	42
Azotæmia*	36	22	28	78
Pulmonary œdema ..	28	8	26	93

*Adults only.

This table shows the incidence of the more important complications and their relationship to mortality rates. The mean mortality rate in the whole series was about 40%.

Vascular shock was very common especially in the first stage. It is often very difficult to pull these patients out of this state of vascular collapse, presumably because of lesions in the region of the medullary vasomotor centres.

Pulmonary œdema was quite common in the last phase of the disease. We saw it a few times after the removal of bronchial plugs, but the pathogenesis of this complication presumably most often was anoxic capillary lesions, myocardial damage and—a few times—too much intravenous fluid. Treatment was on the usual lines, but, as will be seen, it was not very effective.

Azotæmia of a very pronounced degree was quite common in these patients, probably because of increased decomposition of muscle protein. In some cases with impaired renal function on account of shock non-protein nitrogen values were especially high and the prognosis was very bad.

Hyperpyrexia, that is a temperature higher than 102° for more than five days after admission or until death, was not uncommon.

We do not know the pathogenesis of this pyrexia, but as it was present in many patients where an infectious origin was rather improbable, we felt it must be of central genesis. When this complication is present prognosis is almost invariably bad.

Certain complications such as *paralytic ileus*, *atonia of the stomach* and *arterial hypertension* were quite common but did not result in higher mortality rates.

After 26 August, 321 patients requiring special therapy were treated according to the principles I have already mentioned (Table V).

TABLE V

321 patients with respiratory insufficiency or with impairment of swallowing
or with both (April 1, 1953)

	Men	Women	1-14 years	Below 1 year	Total
No. of patients	84	72	158	7	321
No. died	41	21	54	3	119
No. died (within 24 hours) ..	2	1	19	1	23
Mortality rate ..	49%	29%	34%		38%
Still artific. resp.	15	13	10	1	39
Spont. respt. trach. cannula ..	1	2	9	1	13
Spont. respt. cannula removed..	22	22	27	1	72

There was an equal number of children and adults. The percentage of adults is much higher than in the 2,300 patients with paralytic and non-paralytic polio. Of 321 patients 265—that is 82%—were treated with tracheotomy and of these, 232 had manual bag ventilation. The mean mortality rate was 39%. Adult women fared much better than adult men—29% against 49%. Why? we do not know.

Of the 119 who died, 23 patients died during the first 24 hours after admission, while 77 died during the first week. This gives an impression of the severity of the epidemic.

TABLE VI.—MORTALITY RATES

Group	Period of admission	No. of cases	No. died	Per cent
I	7/7 -25/8	31	27	87
II	26/8 - 8/9	50	27	54
III	8/9 -23/9	50	25	50
IV	23/9 - 5/10	50	20	40
V	6/10-21/10	50	13	26
VI	21/10- 6/11	50	18	36
VII	6/11-23/12	50	11	22
Total II-VII		300	114	38

Table VI shows mortality rates in 331 patients requiring special treatment. First the group treated during the first month of the epidemic before bag ventilation was introduced: 87% died.

The next 6 groups each comprises 50 consecutive cases in chronological order without any omissions. The table shows that the mortality rate for these patients, of whom the great majority were treated by tracheotomy and bag ventilation, was reduced from over 80% to about 40%, representing about 120 lives. We are quite convinced that by far the greater number of these patients were saved by early tracheotomy combined with bag ventilation, and, further, that no mechanical respirator could have taken the place of the bag ventilation with equally good results. Here, too, the day of reference is April 1, 1953.

Observing the decreasing mortality rate during the course of the epidemic, we naturally searched for evidence of decreasing severity of the bulbar cases but could not find any, a clinical impression which is supported by the somewhat higher mortality rate in group VI.

Since the survey was made only comparatively few patients have died, up to date about 130 of a total of 350 requiring special treatment. 150-160 have been discharged with varying degrees of peripheral paralysis, yet, quite a fair number have only slight residual paralysis or no paralysis.

60-65 patients are still in the hospital and of these about 25 are still dependent on artificial respiration. Only very few of these unfortunates will ever regain enough spontaneous respiration to get rid of respiratory aid. In these patients ventilation had been mechanized in nearly all. Not one single patient is in a body respirator.

We do not think that this method is ideal, but we are still working at improving it. However, in comparison with the results formerly obtained in our hospital, it seems fair to regard the results as satisfactory in the circumstances.